U.S. Department Of Energy
Hydrogen Workshop
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Coal's Role In Energy Security …
The Bridge To Renewables
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#1: Title Slide

Good morning.

I was an undergraduate engineer — a geotechnical engineer — in the late 1960s. I vividly remember only one issue of the quarterly publication of the Cornell University - College of Engineering. Although I had not developed an interest in the energy sector, I was impressed by the elegance of the program which was detailed. The "cover story" of the publication was entitled "The Hydrogen Economy." Its promise was for clean, affordable energy that would enable the United States to maintain its leadership position in energy development.

Fast-forward 35 years. I believe that the goals cited in that publication are still valid today — the timing may have been off, but the mission remains the same.

#2: Graph of OPEC Oil Production

I frequently begin discussions of coal's role in national security with the following graph.

This shows International Energy Agency's projections of the growing dominance of OPEC oil production.

We need to worry a great deal about the consequences of this graph, and ensure that our policies do not aggravate this situation.

The concerns of the energy crisis of the 70s and 80s have faded. Despite the recent spike in gasoline prices in the midwest, electricity shortages on both coasts, and high natural gas prices country-wide:

- We still seem complacent about the future price and availability of energy.

- We also seem complacent about the geopolitical costs of relying on volatile and uncertain oil and natural gas supplies.

How has the illusion of abundance occurred?

- Technological advances in production of and exploration for fossil fuels have brought forth more energy supply at lower costs than most imagined possible only a short time ago.

- The growth of nuclear electricity generation also has contributed to the current perceptions of abundant energy. Nuclear power has helped to meet growing energy demands over the past two decades; and

- The growth of power generation from coal has occurred as power plants constructed in the 70s and 80s have increased utilization. We have met power needs without new base load capacity.

Overlooked in the policy rush to environmental goals in recent years is an almost self-apparent truism — that vital international coal and coal-fired power industries are absolutely essential to the stability, security and cost of the world's energy supply.

#3: Coal's Attributes

I'll not dwell on energy statistics because that is your business and you know the numbers as well as I do. Coal accounts for some 25 percent of world energy supplies and about 40 percent of world electricity generation. As a result of its wide resource base, coal has the potential to supply energy to the world population for more than 200 years.

We don't believe that the reserves will be needed, nor will the combustion of all this coal be positive for the environment. What we do

believe is that technological advances will enable a natural, gradual, market-driven transition to renewable energy sources in the 2050 to 2100 time-frame.

Coal producing countries are spread broadly over the world. The top ten countries in terms of coal reserves are the Former Soviet Union, the US, China, Australia, India, Germany, South Africa, Poland, Indonesia and Canada. These countries account for 92% of total world reserves … and these countries are also the world's ten largest producers.

Coal is a relatively conflict-free energy source compared with oil and gas. This is on the grounds of the quite different geographical distribution of the resource. Gas reserves are not only relatively scarce, but also concentrated in politically and economically unstable crisis regions of the world — OPEC and the former Soviet Union. Before long, these two regions will determine international gas supplies. The policy of diversifying the supply sources for gas increasingly encounters geopolitical limits.

U.S. Coal Consumption

U.S. coal consumption has increased from 951 million tons in 1994 to 1,041 million tons in 1999, a 1.8 percent annual rate.

The main advantage to continue using coal, as often pointed out by Secretary Richardson — is that it uses existing infrastructure. In fact, coal "supports" much of the railroad and river system infrastructure that is then used for other purposes.

Productivity and cost in the coal industry have continued to show improvements over time. Technological change in mining and processing has been a major contributor to the productivity gains, as have improved management practices. Technological advancements in mining and processing equipment are expected to continue in the future, augmented by new information management opportunities such as GPS and computerized automatic control systems.

The critical issues for future supply of coal are (1) the premature closure of existing mines due to environmental permit restrictions and (2) the longevity of reserves that can be accessed from existing infrastructure given the aging of U.S. mines.

Let's move now to an area of great importance to us – the environment.

Environmental restrictions — particularly as they relate to short-term CO_2 emission reductions — clearly would reduce the demand for coal. Such policies would have a detrimental impact upon investment in coal production and infrastructure with a consequential deterioration of energy diversity and sustainability.

Governments should not take comfort from the relative ease that a few countries such as those of the UK have reduced their dependence on coal. This has been accomplished only because coal remains as the foundation of the energy supply for the remainder of the world.

Clean coal technologies should be encouraged to reduce emissions while maintaining the competitiveness of coal. The importance of maintaining coal in the energy mix is extremely important for world energy price stability and energy security.

The world's energy supply likely will be at least partially decarbonized in the next cycle of energy evolution. Technology will enable this natural transformation to occur over a 100-year period, in a time frame sufficient to enable the current generation of capital stock and energy resources to fulfill their economic lives. The artificial acceleration of decarbonization would have huge economic costs and, we believe, will be unnecessary for eventual stability of CO_2 concentrations in the atmosphere.

#4: Energy Production/Usage

For those of us who work in the energy field, our day-to-day jobs can typically be pigeon-holed in one of the boxes shown on this diagram. Every form of energy has problems to solve in each of the boxes — but some are clearly more formidable than others, depending on the energy area in which you work. You may want to think about these boxes when you think about your blueprint.

Hydrogen is unique in that there is no current infrastructure. This means major problems (read costs) in each of the boxes. That is why I believe that with limited resources, the bulk of the efforts need to be focused on the production box, including CO_2 sequestering.

I would suggest that you do not burden the H_2 program by trying to get it into every car or house, or eliminating the emission of every molecule of CO_2. The suggestion — don't try to replace natural gas — try to complement gas.

#5: Energy Prices

As I look at the future of my business — the coal business — from a strategic viewpoint, I always look at what "trumps" coal. For this reason, I pay a lot of attention to the price of natural gas.

However, it is clear to me that the ultimate "trump card" is hydrogen — since hydrogen will cap the price of natural gas by producing H_2 from coal — until renewables can do it more cheaply.

Let's look at why this is an important issue … by looking at energy prices one year ago versus today.

Liquid fuels and natural gas move in lock-step. Trying to achieve economics for large-scale H_2 production from natural gas is equivalent to "chasing your tail."

This is the critical reason coal is so important to our hydrogen energy future … coal prices do not move in lock-step with oil and gas prices.

#6: Economics of Hydrogen

I know that you are going to discuss the very complicated economics of producing hydrogen from fossil fuels. However, my first question will always be to compare the cost of hydrogen production from coal, natural gas and petroleum.

I asked the simple question — how much hydrogen is there in coal, oil and natural gas? My logic was that if you can magically remove the H_2, and throw away everything else, what would the hydrogen cost?

I've been told by our Research Department that you can crudely represent coal as C-H, petroleum as C-H_2, and natural gas as C-H_4. They tell me, further, that the contribution of H_2 to the heating value of the respective fossil fuels is as shown. Based on typical prices for the fuels, we can calculate the value of H_2.

Hydrogen from coal is very cheap "if you believe in magic."

Another way of looking at this simple calculation is that hydrogen from petroleum and natural gas is a losing proposition, because the prices will move in lock-step.

I understand that the current thoughts are that hydrogen can be converted from coal at about $7 per MMBtu.

Coal is the ideal fuel for extracting H_2 for one simple reason — its energy content is cheaper than that of natural gas or oil. If you can get the carbon in the coal to "pay for" the processing cost of H_2 and the sequestration of undiluted CO_2 — you will have a winner. Not only do you have H_2, but you may have some excess electricity to sell, some ash to sell for roadbed materials, some elemental sulfur for the chemical industry and concentrated CO_2 to inject underground to stimulate gas or oil production.

As I've always said, the problem with natural gas is that when you burn it, you don't have anything left to sell — as you do with coal!

Roadmap

As you develop your "roadmap" for identifying approaches to producing and utilizing hydrogen, we suggest that you consider the following:

#7:
Implementation

- "Decarbonized fuel" from coal should have tremendous appeal on "both sides of the aisle" because of its energy security and environmental virtues.

- Base-load electricity generation from the clean, efficient combustion of coal in power plants, combined with peak-load generation using coal-based hydrogen with CO_2 sequestration, and distributive-generation with natural gas is a rational portfolio target.

- Coal is the logical source as a transitional fuel to create H_2 … with the eventual goal of H_2 from renewables.

- Steam-reforming of coal to produce H_2 will cap natural gas prices, until electrolysis of H_2O from sunlight "caps" both.

#8: Process Technology

- Research efforts, especially on the production and sequestration efforts, need to be stepped up.

- The primary focus should be on process development. The private sector will take care of storage, transport and usage — if H_2 can be made competitive with natural gas.
- The natural gas/coal price spread will drive the program to develop process improvements.

- The coal industry stands ready to provide a low cost, secure feedstock for H_2 production.

- Coal-bed methane from unmineable coal seams should be considered for coalbed methane recovery, methane reformation to H_2, and perhaps CO_2 injection for well stimulation.

#9: Utilization

From a hydrogen usage perspective, work is going on with the Mine Safety and Health Administration using hydrogen to power mining equipment and to eliminate trolley wire or diesel from underground. The hydrogen is stored as a metal hydride in this application.

The mining industry is frequently at the lead of such developments due to the work environment that demands low-noise and low-polluting mobile power.

I know that there are naysayers that will tell you that we cannot produce hydrogen from coal with CO_2 sequestration, because it's not economic with natural gas.

I believe that their logic error is that they still think in terms of $15 oil and $2 natural gas. Besides, if hydrogen from coal were economic today, we wouldn't need the National Energy Technology Labs. Private enterprise would raise the capital and build the plants.

The "hydrogen program" is a classic example of why the work of the National Labs is so critical.

If I were Vice President Gore or Governor Bush, I would be stopping right here for my nightly news soundbite on "my programs to control spiraling energy costs." I would tell the senior citizens to quit worrying about the cost of prescription drugs because "you aren't going to have any money left over anyway — after you pay your heat and light bill!"

Conclusion

The leadership of the Department of Energy for at least 2½ years has trumpeted the Department's objectives "in the climate change portfolio." At every workshop and presentation we hear the "three legs" of DOE policy:

- Expand the use of lower carbon fossil fuels (natural gas).
- Use energy more efficiently.
- Carbon sequestration.

It is worthy to note that the "hydrogen program" embodies all three legs of the DOE climate change policy.

Furthermore, Secretary Richardson, on numerous occasions, has underscored his commitment to coal's future.

The "stump speech" by the Secretary and his lieutenants reads that "30, 50 or 70 years in the future, carbon sequestration could offer one of the best options for reducing the buildup of greenhouse gases."

This is where I respectfully part with the Secretary, and I would suggest that the results of this workshop enable him to "tweak" his words.

I will hope to hear that "30, 50 or 70 years in the future hydrogen production from renewables will offer one of the best options for reducing the build-up of greenhouse gasses. In the next 10-30 years, hydrogen production from abundant coal with carbon sequestration will form a secure, economic and clean bridge to the renewables future."

As I already mentioned, I am a geotechnical engineer in my formal education. My early career was in the design of foundations and earth structures primarily for our energy infrastructure. I've worked on foundation design for nuclear power plants, LNG facilities and the Alaska pipeline.

In foundation design — you prepare for the event that causes the highest stress condition. For buildings — this is typically an earthquake.

In my discussions on the importance of coal to our energy security, I often like to create the analogy that "coal is the pillar … coal is the underpinning … of world energy security."

Imagine a high-rise hotel that has been standing for 30 years. It was built in 1970 in a coastal town with a pile foundation down to bedrock — fifty feet below. It is not as bright and shiny as the new hotel that was built in 1990 right next door. The new hotel owners (I think it's owned by a natural gas company) said that they can make the lobby snazzier if they cut out the pile foundation, and don't underpin the building to bedrock.

Since you can't see the foundation, the new hotel actually looks better to the public … and both operate well under normal dead-load and live-load conditions — until the day the earthquake hit. The hotel without the underpinning tilted, cracked and suffered great distress. The 30-year hotel with the underpinning weathered the disaster.

Interestingly, this is exactly what happened to buildings on the sandy soils of Kobe, Japan during the devastating earthquake early in the morning of January 17, 1995.

About 20 miles up the road from Kobe is a city that happens to have been spared the brunt of the earthquake, although it did have severe damage: That city is Kyoto.

Kyoto is the epicenter of another earthquake that is rocking the buildings and lifeline infrastructures of the world. It is not the 20 second shock of the 1995 earthquake at Kobe, rather shock waves will span over the years. The "hotels" … the "economies" that will survive, are those with energy economies that have strength; that have underpinning; that have the technical resources that embody the work that you are doing.

Coal is the current "pillar" that will prevent economic damage due to the energy shocks. I have every reason to believe that hydrogen from coal, and electricity from clean, efficient coal-fired plants, will be the way that the United States can advance its missions of a secure, economic and clean energy.

Thank you.

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